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Code of Practice for the Management of Air Emissions from Pulp and Paper Facilities

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Abstract

The *Code of Practice for the Management of Air Emissions from Pulp and Paper Facilities* (Code of Practice) outlines the operational activities for this industry and the environmental concerns related to the atmospheric emissions of sulphur dioxide (SO_2) and total particulate matter (TPM). Emission limits and recommended practices that can address these concerns are also described.

Some, or all, of the provisions of the Code of Practice may be implemented voluntarily by the industry, or adopted as requirements by financial institutions or regulatory agencies; however, they do not negate any applicable regulatory requirements.

Résumé

Le *Code de pratiques pour la gestion des émissions atmosphériques des installations de pâtes et papiers* (Code de pratiques) décrit les activités opérationnelles de ce secteur industriel et les préoccupations environnementales qu'elles soulèvent, liées aux émissions atmosphériques de dioxyde de soufre (SO_2) et de matières particulaires totales (MPT). Des limites d'émissions et des pratiques recommandées sont présentées pour atténuer ces préoccupations.

Certaines des dispositions du Code de pratiques, voire toutes, peuvent être mises en œuvre à titre volontaire par l'industrie, ou être adoptées à titre d'exigences par les institutions financières ou organismes de réglementation, mais n'annulent pas les exigences réglementaires qui peuvent s'appliquer.

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Definitions

Boiler

An enclosed device which uses controlled flame combustion and is designed to transfer thermal energy from the combustion of a fuel indirectly to a fluid (such as water or oil.)

Chemical facility

Any pulp and paper facility that is designed to operate a recovery boiler, a lime kiln or a pulping digester.

Continuous Emissions Monitoring System (CEMS)

Equipment for automated sampling, conditioning or analyzing of emissions from a given source and the recording of data related to those emissions.

Digester

A pressure vessel used to chemically treat chips and other cellulosic fibrous materials under elevated temperature and pressure in order to separate fibres from each other and produce pulp.

Dissolving tank

Equipment that collects molten smelt from the recovery boiler's furnace hearth and dilutes it, usually with water or weak wash from the washing of lime mud and green liquor dregs.

High-volume, low-concentration (HVLC) non-condensable gases

Gases with low total reduced sulphur (TRS) content. HVLC non-condensable gases typically come from washers, filtrate tanks, knotters, screens, deckers, oxygen delignification systems, weak liquor storage tanks, and intermediate pulp storage chests. Also known as diluted non-condensable odorous gases (DNCGs).

Lime kiln

Equipment used to calcine lime mud, which contains calcium carbonate ($CaCO_3$) and water, in order to form lime (CaO) and CO_2.

Low-volume, high concentration (LVHC) non-condensable gases

Gases with high total reduced sulphur (TRS) content. LVHC non-condensable gases typically come from blow heat recovery systems, turpentine recovery systems, digester areas, evaporators, and steam strippers. Also known as concentrated non-condensable gases (CNCGs).

Mechanical facility

Any pulp and paper facility that is not a chemical facility.

Operator

The operator of a pulp and paper facility is an authorized official who:

- in respect of a corporation, is an officer of the corporation who is authorized to act on its behalf;
- in respect of any other person, is that person or a person authorized to act on behalf of that person; and
- in respect of any other entity, is a person authorized to act on its behalf.

Other stationary combustion source

Any stationary combustion equipment with a nominal heat capacity greater than 10.5 gigajoules per hour (GJ/h) that was operated more than 500 hours in the year of declaration.

Pulp and paper facility

"Pulp and paper facility" means a facility that is designed or used to produce
(a) pulp products from wood, other plant material or recycled paper products; and
(b) any other product obtained from a pulping process or directly derived from pulp.

Recovery boiler

Equipment that burns spent pulping liquor to allow for the recovery of cooking chemicals.

Stripper off-gases (SOGs)

Gases leaving a steam or air stripper column that treats foul condensates.

Thermal oxidizer

Device used to destroy liquid, solid or gaseous matter through combustion, without recovering the energy produced.

Total particulate matter (TPM)

Airborne particulate matter with an upper size limit of approximately 100 micrometres (μm) in aerodynamic equivalent diameter. Only the filterable portion is considered in this Code of Practice.

List of Abbreviations

AQMS:	Air Quality Management System
BLIERs:	Base Level Industrial Emission Requirements
Ca:	calcium
$CaCO_3$:	calcium carbonate
CaO:	calcium oxide, lime
CCME:	Canadian Council of Ministers of the Environment
CEMS:	continuous emissions monitoring system
CMP:	chemi-mechanical pulping
CNCGs:	concentrated non-condensable gases
CO:	carbon monoxide
CO_2:	carbon dioxide
DNCGs:	diluted non-condensable gases
GJ:	gigajoules
GJ/h:	gigajoules per hour
H_2SO_3:	sulphurous acid
HVLC:	High-volume, low-concentration non-condensable gases
ISO 14000:	International Organization for Standardization, environmental management
LVHC:	Low-volume, High-concentration non-condensable gases
Mg:	magnesium
Na:	sodium
Na_2CO_3:	sodium carbonate
Na_2S:	sodium sulphide
Na_2SO_3:	sodium sulphite
NaOH:	sodium hydroxide
NCGs:	non-condensable gases
NH_4:	ammonium
NO_x:	nitrogen oxide
PGW:	pressure groundwood pulping
PRMP:	pressure refiner mechanical pulping
RMP:	refiner mechanical pulping
SGW:	stone groundwood pulping
SO_2:	sulphur dioxide
SOGs:	stripper off-gases
TMP:	thermo-mechanical pulping
TPM:	total particulate matter
TRS:	total reduced sulphur
VOCs:	volatile organic compounds

1 Introduction

1.1 Background

At a meeting of the Canadian Council of Ministers of the Environment (CCME) on October 11, 2012, federal, provincial and territorial environment ministers approved further action to protect the health of Canadians and the environment including the adoption of measures to improve air quality in Canada through a comprehensive new Canada-wide system: the Air Quality Management System (AQMS). Ministers agreed to a flexible approach to implementation that would help jurisdictions ensure good air quality outcomes, while maintaining competitiveness throughout Canada. The AQMS has several components, including Base Level Industrial Emission Requirements (BLIERs) that set a base level of performance for major industries in Canada.

The BLIERs are intended to serve as quantifiable requirements in the form of performance standards that can be incorporated into an instrument such as a regulation. They should result in compliance of all major industrial sources in Canada, regardless of the air quality where the factories and industrial facilities are located, with an acceptable basic environmental performance level.

The expert group that developed the BLIERs for pulp and paper was composed of representatives from federal and provincial governments, one non-governmental organization and representatives from the pulp and paper industry. At the federal level, the group included representatives from departments of the Environment, Natural Resources and Health.

A consensus was reached in December 2011 on the Pulp and Paper BLIERs for sulphur dioxide (SO_2) and total particulate matter (TPM), which were accepted by the CCME.

1.2 Description of the Pulp and Paper Sector

The Canadian pulp and paper is present throughout Canada, except in Prince Edward Island and the territories.
The pulp and paper facilities that are subject to the Code of Practice are defined in the "Definitions" section.

1.3 Code of Practice Objectives

The objectives of this Code of Practice are to recommend and promote best practices to facilitate and encourage ongoing improvements in the environmental performance of pulp and paper facilities in Canada with respect to SO_2 and TPM air emissions from combustion sources.

The recommendations set forth in the Code of Practice are not intended to limit the use of other technologies and practices that could provide equivalent or superior environmental protection. The recommendations may need to be interpreted based on the individual conditions and concerns of each facility. In addition, implementing the recommendations does not exempt the facilities from their obligation to comply with all applicable laws and regulations.

The Code of Practice may be applied voluntarily by pulp and paper sector companies, facilities and associations. It may also be adopted in whole or in part by provincial regulatory agencies.

It may serve as a reference for the implementation of best practices to ensure the ongoing improvement of environmental performance in pulp and paper facilities in Canada.

2 Stationary Sources of Emission

The sources of SO_2 and TPM air emissions in the pulp and paper sector considered in this Code of Practice are as follows:

- Boiler
- Recovery boiler
- Dissolving tank
- Lime kiln
- Thermal oxidizer
- Other stationary sources of combustion

A description of these emission sources can be found in the "Definitions" section.

3 Recommended Environmental Protection Practices

This section presents various methods and measures to limit SO_2 and TPM air emissions from pulp and paper facilities. It is not intended to limit the use of other technologies and practices that could provide equivalent or superior environmental protection. Each recommendation's applicability also needs to be assessed based on the individual conditions and concerns of each facility.

3.1 General Practices

Under this Code of Practice, the term "general practices" means the activities, actions, processes and procedures that, aside from legal and technical requirements, help minimize facility emissions. The effective development and implementation of these practices will also facilitate the continuous improvement of overall environmental performance.

Recommendations:

- Each facility should establish and maintain operating procedures and ensure that all staff members are adequately trained on any equipment that generates air emissions, and in the monitoring systems for such equipment.

- Each facility should develop and implement a maintenance and efficiency audit program for emission monitoring devices, including documented
  - maintenance and audit procedures;
  - inspection schedule for each equipment related to air emissions;
  - Procedures to communicate discrepancies to facility management.

- Each facility should develop, implement and maintain an environment management system that is in conformance with a known national standard, such as the International Organization for Standardization (ISO).

3.2 Chemical Facility

The Kraft process is the most common process used in chemical facilities. This process dissolves the lignin that binds the fibres together under the action of the pulping liquor (a sodium hydroxide [NaOH] and sodium sulphide [Na_2S] solution) and high temperature.

For sulphite pulping, the cooking liquor is a solution that can contain sulphurous acid (H_2SO_3), sulphite and bisulphite salts of calcium (Ca), magnesium (Mg), sodium (Na) or

ammonium (NH_4), depending on the base used. Pulping and delignification are also carried out at high temperature.

The following is a description of the main steps found in a chemical facility, with the related concerns and recommendations regarding SO_2 and TPM air emissions.

3.2.1 HVLC and LVHC non-condensable gases

In chemical facilities, production-process-based emissions of gaseous sulphuric compounds are generated from multiple locations in the pulping and chemical recovery areas. They can be low-volume, high concentration (LVHC) non-condensable gases (NCGs) or high-volume, low concentration (HVLC) non-condensable gases. See definitions.

Concern: Sources of SO_2.

Recommendations:

- Collection and treatment of these gases is beneficial as it reduces the discharge of odorous gases to the atmosphere and allows for some energy and chemical recovery.
- The combustion oxidizes TRS gases to SO_2 during incineration. HVLC and LVHC gases can be treated to reduce the sulphur compounds contained in them before incineration, and/or emissions from combustion can be treated in a wet scrubber using alkali in the scrubbing solution. HVLC and LVHC gases can be collected in separate system.

3.2.2 Wood handling and preparation

Fibre is generally received directly in the form of logs, wood chips or sawdust as by-products of the wood products industry, particularly sawmills.

When the fibre is received as a log, it contains bark and must be debarked before being used in the pulping process. The bark is sent to a pile to be used as an energy source and the log is chipped.

Concern: None related to TPM and SO_2.

3.2.3 Pulping and delignification

The fibres are released from the wood matrix by dissolving the lignin and part of the hemicellulose in a pulping solution that contains sodium hydroxide and sodium sulphide (Kraft process) or an acidic solution of bisulphite and sulphite salts (sulphite process). Pulping is carried out in digesters, either as part of a batch or continuous process.

Concern: The digester process, which includes wood chip pre-steaming vessels, blow tanks and relief steam condensers, generates a mixture of sulphur containing gases.
Non-condensable gases from the digester area contain high levels of TRS. The reduced sulphur compounds are transformed into SO_2 if these gases are burned in lime kilns, boilers, recovery boilers or stand-alone thermal oxidizers. Combustion is a common practice used to eliminate NCGs.

Pulping does not represent a significant source of particulate emissions.

Recommendation:

- Lime kilns, boilers, and thermal oxidizers are typically used to burn LVHC gases, while HVLC gases can be combusted in boilers and recovery boilers given that these units can handle larger gas volumes. Provided the associated SO_2 emissions are relatively stable, they can be reduced by installing a wet scrubber using alkali in the scrubbing solution.

3.2.4 Screening and washing of unbleached pulp

The product obtained from the pulping process is a mixture of wood fibre (pulp) and spent cooking chemical (liquor). Depending on the degree of delignification achieved and the type of process involved, nearly 50% of the wood is chemically dissolved during pulping. These wood-based organic and inorganic constituents are contained in the spent cooking liquor. The spent pulping liquor is separated from the pulp (brown stock) in the washing process and sent to the chemical recovery process.

The washed pulp (brown stock) is then screened to remove knots and fibre bundles from the pulp. Rejects from screening and deknotting can be sent back to the digester, burned in boilers, or disposed of in a landfill.

Concern: None related to TPM. Brown stock washers generate gases which arise from the residual spent cooking chemical in the pulp. These gases are a source of odorous reduced sulphur gases, including SO_2.

Recommendations:
To minimize the release of SO_2 emissions from vents of the pulp washing process, vents can be piped to collect the emissions in the HVLC collection system. See section 3.2.1

3.2.5 Bleaching

The objective of bleaching is to remove or oxidize the residual lignin and impurities in the pulp to achieve the desired level and stability of brightness as well as to meet certain cleanness and strength quality criteria. Bleaching is done

in stages, using different chemicals such as chlorine dioxide, oxygen, hydrogen peroxide and sodium hydroxide, depending on the process used and the desired characteristics of the pulp.

Concern: None related to TPM or SO_2.

3.2.6 Drying

In an integrated pulp and paper facility, the bleached pulp is sent in a wet state at a 3–4% consistency to the stock preparation plant for papermaking.

For non-integrated pulp facilities where the pulp is not used for papermaking at the same site, the pulp is treated to facilitate handling. The pulp is first squeezed, then pressed and dried to obtain the desired dryness. The pulp is then cut into sheets, and bales are formed for shipment.

Concern: None related to TPM or SO_2.

3.2.7 Concentration of spent pulping liquor

The weak (10–20% solids) spent pulping liquor is concentrated in the evaporator prior to combustion in the chemical recovery boiler. Concentration of spent pulping liquor is usually achieved by using steam-heated, multiple-effect evaporators and indirectly heated concentrators. Gases released from multiple-effect evaporators consist mainly of TRS and VOCs.

Concern: These gases are commonly collected in the HVLC system and combusted, resulting in SO_2 emissions.

Recommendations:
See 3.2.1

3.2.8 Recovery boilers

The primary purpose of recovery boilers is to initiate the recovery of the inorganic pulping chemicals present in the spent pulping liquor and to burn the organic matter in the liquor in order to obtain a significant portion of the energy (steam) needed by the process. Collected LVHC and HVLC gases are commonly sent to the recovery boiler to be combusted.

Concern: The recovery boiler is a significant source of TPM and SO_2 emissions to the atmosphere.

Recommendations:

- TPM emissions from recovery boilers can be reduced by using electrostatic precipitators (ESP).

- A wet scrubber with alkaline solution can be used on a recovery boiler to minimize sulphur emissions. Given the variability of the level of SO_2 emissions from recovery boilers, removal efficiency can vary but it is typically greater than 90%.
- To minimize SO_2 emissions from the combustion of the collected gases, the collected gases can be treated by an alkaline scrubber prior to being sent to the recovery boiler.
- Increased concentrations of dry solids in the spent pulping liquor help reduce sulphur emissions from the recovery boiler because a higher quantity of sodium is vaporized to react with the sulphur. A new Kraft recovery boiler can have a percentage of dry solids in the spent pulping liquor greater than 80%. However, this could increase TPM and nitrogen oxide (NO_x) emissions from the recovery boiler if no countermeasures are in place.
- Sulphur emissions from recovery boilers can be minimized by controlling the combustion process parameters, including temperature, air intake, spent pulping liquor distribution in the recovery boiler, and boiler load. In a Kraft recovery boiler, the creation of conditions for a hotter lower furnace zone results in higher relative amounts of volatilized sodium compounds (from the molten char formed both within the char bed and within the falling liquor droplets), which then react with SO_2 to produce sodium sulphate, thereby lowering SO_2 emissions.
- For sulphite facilities, recovery boilers can be paired with scrubbers/washers with alkaline solution to capture the sulphur and chemicals from the burned spent liquor. To control the emission release during the flushing and cleaning of the deposits in the scrubbers and washer, a bank of scrubbers/washers can be use in order to have the flue gases treated by one during the cleaning of the other.
- To further control these emissions, all the emission control devices (multicyclone or electrostatic precipitator, multistage scrubbers) must have the proper layout and operating set-up, which is site-specific.

3.2.9 Smelt dissolving tank

The dissolving tank receives the smelt from the recovery boiler. The dissolving tank vents gases containing high amounts of TRS and particulates. It generates lower levels of SO_2 emissions. Vent gases have a high moisture content. Molten smelt is drained from the chemical recovery boiler into the dissolving tank, where it is diluted with "weak wash" to form green liquor. The dissolving tank is not a significant source of SO_2 emissions but the moisture-laden dissolving tank emissions contain TRS and particulate matter.

Concern: The smelt dissolving tank emissions are a significant source of TRS and particulate matter. The dissolving tank vent gases are commonly collected in the

LVHC and sent to combustion. The combustion of concentrated TRS emissions transforms the reduced sulphur into SO_2 emissions.

Recommendations:

- Gaseous emissions from the dissolving tank can be reduced by treatment in a wet scrubber using an alkaline solution such as weak wash.
- Particulate emissions from the dissolving tank can also be treated in a wet scrubber and then a mist eliminator to removed entrained droplets.
- Incineration of vent gases can be done in lime kilns, thermal oxidizers, boilers or in more recently built, recovery boilers or those modified for the incineration of dissolving tank vent gases.
- Dissolving tank gases that are to be incinerated in a recovery boiler must first be conditioned by passing them through a direct contact condenser, a mist eliminator, and a reheater. With this approach, the recovery boiler is the unit that ultimately handles the load of TPM, TRS and SO_2 from the dissolving tank.

3.2.10 Lime kiln

The Lime kiln is part of the pulping liquor regeneration cycle, transforming the calcium carbonate ($CaCO_3$) into lime (CaO) and carbon dioxide (CO_2). It generally uses fossil fuels to supply heat for mud drying and chemical reaction. The gases exiting the kiln are laden with particulate matter (lime dust) and may also contain sulphur compounds originating from liquor carryover in the lime mud. Lime kilns can also be used to incinerate LVHC and HVLC non-condensable gases, thereby oxidizing the odorous reduced sulphur compounds into SO_2.

TPM emissions primarily depend on fuel type, combustion technology and emission control device, while SO_2 emissions mostly depend on the fuel's sulphur content (e.g., fuel oil, petroleum coke, NCGs or SOGs) and, sometimes, post-combustion controls (e.g., gas desulphurization). A relatively smaller portion of the sulphur comes with lime mud.

Concern:

TPM and SO_2 are significant emissions from lime kilns because

(1) a large portion of the sulphur coming into the kiln with the fuel is oxidized to SO_2 under normal conditions; and

(2) high levels of particulate matter are picked up by combustion gases as they pass through the kiln.

Recommendations:

- For SO_2 emission reduction from lime kilns, wet scrubbers with alkali solutions may be a possible solution.
  When sulphur-containing fuels are incinerated in a lime kiln, a portion of the sulphur can be absorbed by the lime product up to a certain total sulphur input. Beyond this point, SO_2 emissions can be reduced by limiting the overall amount of sulphur input to the kiln via fossil fuels and non-condensable gases (NCGs), including low volume, high concentration of (LVHC) and stripper off-gases (SOGs).
- When burning LVHC or SOGs in the lime kiln, facilities could use a wet scrubber to reduce the sulphur compounds contained in these gases before incineration.
- With effective mud washing and filtration, the soluble sulphide in the lime mud can be reduced prior to entering the lime kiln, thereby reducing the amount of sulphur that is oxidized to SO_2 during incineration.

To reduce TPM emissions, ESPs or bag filters can be used as end-of-pipe controls.

3.2.11 Preparation of chemicals

The most common bleaching chemicals used in the Kraft process are chlorine dioxide, ozone, oxygen, and peroxide.

There are a number of ways to generate chlorine dioxide. In Canada, it is generally obtained from sodium chlorate. To transform the chlorate ion into chlorine dioxide, a reducing agent such as a chloride ion, hydrogen peroxide, sulphur dioxide, or methanol is used.

Ozone should be produced on-site because of its instability. It is made by placing oxygen between two high-voltage electrodes.

Concern: None related to TPM or SO_2.

3.2.12 Boilers

Boilers are typically used to produce steam which can serve various purposes, such as process heating and electricity production.
Boilers may use only one type of fuel (e.g., gaseous), switch between different fuels, or use multiple fuels simultaneously or in alternation (e.g., natural gases and heavy fuel oil). Combustion of solid fuels, such as biomass, generates emissions laden with particulate matter. Combustion of sulphur containing fossil fuels and/or combustion of LVHC/HVLC non-condensable gases can lead to SO_2 generation.

Concern: Boilers can be used to combust fuel and waste streams which can carry various pollutants. The boiler could be a significant source of SO_2 and TPM emissions to the atmosphere.

Recommendations:

- TPM emissions can be reduced by using an electrostatic precipitator and/or efficient bag filters. Both ESPs and bag filters can be highly efficient particulate removal devices with design efficiencies in excess of 99%.

- SO_2 emissions can be reduced by switching to lower sulphur content fuel or by installing a wet scrubber with alkaline solution.

3.3 Mechanical Facility

The mechanical and chemi-mechanical pulping processes require mechanical action and use very few chemicals, or none at all, to separate the fibres. In the chemi-mechanical process, the wood chips are chemically treated only slightly before refining.

There are several methods for producing mechanical pulp, depending on whether chemical treatment took place, the type of fibre-separation process, and the pressure used, such as:

- stone groundwood pulping (SGW) or pressure groundwood pulping (PGW): the debarked logs are defibred by pressing them against an abrasive stone;
- refiner mechanical pulping (RMP): the chips are defibred between two rotating discs;
- pressure refiner mechanical pulping (PRMP): the chips are defibred between two rotating discs, under pressure;
- thermo-mechanical pulping (TMP): the chips are steamed then defibred between two rotating discs, generally under pressure;
- chemi-mechanical pulping (CMP): the chips are impregnated with a chemical product (sodium sulphite [Na_2SO_3], sodium hydroxide [NaOH], sodium carbonate [Na_2CO_3]) then defibred by one of the refining processes;
- repulping: dry pulp is moistened and mashed by a mechanical agitator until the fibres separate and the desired consistency is obtained

The following is a description of the main steps involved in making mechanical pulp, along with the concerns and recommendations regarding SO_2 and TPM atmospheric emissions.

3.3.1 Chip handling and preparation

The fibre is generally received in the form of chips, a by-product of the wood products industry, particularly sawmills. The chips are screened to remove

sawdust and pieces that are too large . The large chips can be recut to the desired size. The screened chips are then washed to remove all debris that could damage the refiners.

Concern: None related to TPM or SO_2.

3.3.2 Heating wood chips

In the TMP process, wood chips are heated with steam under pressure for a few minutes before they are refined.

Concern: None related to TPM or SO_2.

3.3.3 Impregnation

This step is mainly used in the chemi-mechanical process. The wood chips are impregnated with a chemical product (Na_2SO_3, NaOH, Na_2CO_3) before they are refined, using one of the mechanical pulping processes.

Concern: None related to TPM or SO_2.

3.3.4 Separation of fibres

In the stone groundwood pulping process, debarked logs are pressed against a grinding wheel.

In the refining process, wood chips and water are forced between two rotating discs a millimetre or less apart. On the surface of each disc, slits and bars compress and shear the wood chips in order to defibre them. Part of the energy used by the refiner transforms the water into steam.

Concern: During refining, the steam that is produced carries pollutants such as particulate matter.

Recommendation:

- Using a scrubber on the dirty steam produced or using a steam recovery system substantially reduces TPM emissions and improves the facility's energy efficiency.

3.3.5 Screening and cleaning

Pressure screens and hydrocyclones are used to clean the pulp. Baskets with slits or holes are used for screening. Rejects are sent to the next stage in a cascade arrangement or directly to the reject refining stage.

Concern: None related to TPM or SO_2.

3.3.6 Thickening

A disc filter or a screw press is used to thicken the final pulp product. This stage is essential in order to remove part of the dissolved matter in the water—matter that could affect the paper machine—and to maximize the pulp storage tank's capacity.

Concern: None related to TPM or SO_2.

3.3.7 Bleaching

Hydrogen peroxide or sodium hydrosulphite is generally used in mechanical pulp bleaching. There may be one or two bleaching stages, depending on the brightness sought.

Concern: None related to TPM or SO_2.

3.3.8 Boiler

Boilers provide the energy required for the process. The same concerns and recommendations apply as with the boiler in the chemical facility process (Section 3.2.12).

4 Annual Air Emission Limits

Pulp and paper facilities should limit their annual sulphur dioxide (SO_2) and total particulate matter (TPM) emissions to the following:

a. In the case of a chemical facility:
   - 4.0 kg of SO_2/tonne of production
   - 2.0 kg of TPM/tonne of production

b. In the case of a mechanical facility:
   - 1.5 kg of SO_2/tonne of production
   - 0.5 kg of TPM/tonne of production

Note: The limits may be implemented voluntarily by the industry but do not negate any other regulatory requirements that may apply.

Refer to Appendices 1, 2 and 3 for calculations.

5 Meeting the Limits

5.1 Operator Declaration

The operator of a pulp and paper facility should inform the federal Minister of the Environment in writing that it intends to implement the Code of Practice; this notice should be provided no later than January 21, 2019 *(six months after the Code is published)*.

5.2 Characterization of Air Emissions

The operator of a pulp and paper facility should characterize its atmospheric SO_2 and TPM emissions in accordance with the procedure set out in Appendix 2.

5.3 Compliance Emission Assessment

5.3.1 Initial emission assessment report

The operator of a pulp and paper facility should assess its emissions against the annual limits specified in Appendix 1 for year 2018, 2019 or 2020. The facility should provide the initial emission assessment report to the federal Minister of the Environment no later than June 1, 2021.

5.3.2 Follow-up emission assessment report

The operator of a pulp and paper facility should submit its subsequent emission assessment reports according to the following schedule:

- Second emission assessment report, for year 2024: submit by June 1, 2025
- Third emission assessment report, for year 2028: submit by June 1, 2029
- Fourth emission assessment report, for year 2032: submit by June 1, 2033
- Fifth emission assessment report ...

If the facility does not meet the annual limits specified in Appendix 1:

- It should submit its emission assessment report once a year until it meets the limits.
- Once it meets the limits, the facility should follow the regular schedule as indicated above.

5.3.3 Emission assessment report procedure

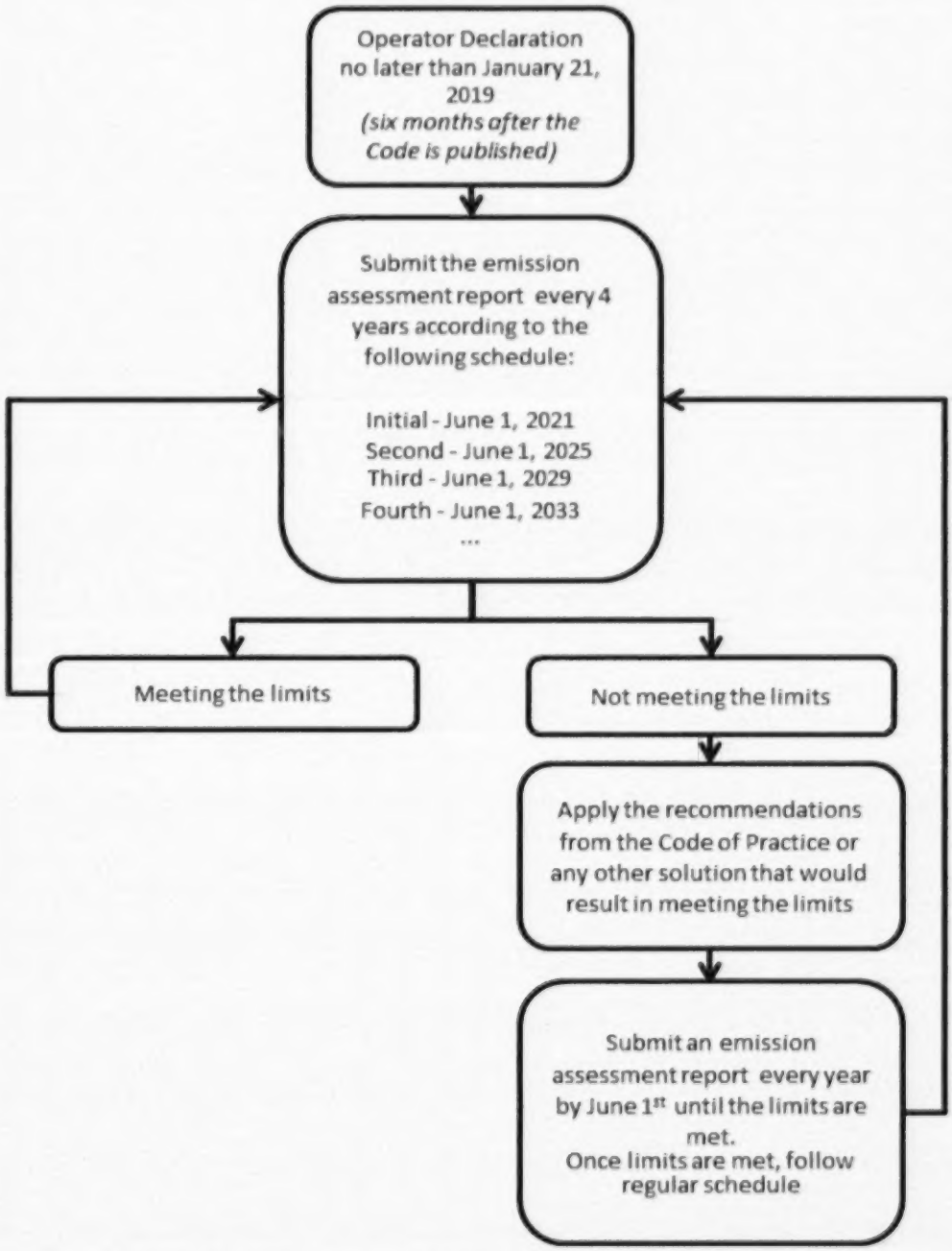
Operator Declaration no later than January 21, 2019 (six months after the Code is published)
Submit the emission assessment report every 4 years according to the following schedule:
Initial - June 1, 2021
Second - June 1, 2025
Third - June 1, 2029
Fourth - June 1, 2033
...
Meeting the limits
Not meeting the limits
Apply the recommendations from the Code of Practice or any other solution that would result in meeting the limits
Submit an emission assessment report every year by June 1st until the limits are met.
Once limits are met, follow regular schedule

Figure 1: Emission assessment report procedure

5.4 Emission Assessment Report

Following each emission assessment, the operator of a pulp and paper facility that commits to applying this Code of Practice should provide the federal Minister of the Environment with a report containing the following:

- the name and civic address of the facility
- the name, telephone number, position title and email of the technical resource person
- the calendar year covered by the report
- the calculated annual limit for each pollutant
- the annual quantity of SO_2 and TPM released by each type of emission source
- the methods used for estimating/measuring emissions
- where applicable, if the total facility annual emission is higher than the annual limit: the potential causes/reasons and the planned actions to meet the limits

A template for the emission assessment report is presented in Appendix 4.

5.5 Record Keeping

The operator of a pulp and paper facility should retain all relevant files as prescribed by the applicable federal, provincial or municipal authorities, and should be able to provide them to the federal Minister of the Environment upon request. A record of all relevant files must be kept for a minimum of 5 years following the submission of the emission report.

6 References

Best Available Techniques (BAT) Reference Document for the Production of Pulp, Paper and Board Industrial Emissions Directive 2010/75/EU, European Commission, 2015.

Browne, Thomas. *Energy Cost Reduction in the Pulp and Paper Industry: A Monograph*. Ed. Peter N. Williamson. First ed. Pointe-Claire, Quebec: Pulp and Paper Research Institute of Canada, 1999. Print.

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Frederick, W.. J., Thomas M. Grace, Kristiina Lisa, Andrew K. Jones, and Honghi Tran. *Kraft Recovery Boilers*. Ed. Terry N. Adams. Atlanta, GA: Tappi, 1997. Print.

Lavigne, John R. *Pulp & Paper Dictionary*. San Francisco: Miller Freeman, 1998. Print.

Paulapuro, Hannju. *Chemical Pulping*. Ed. Johan Gullichsen and Carl-Johan Fogelholm. Vol. 6A. Helsinki, Finland: Fapet Oy, 1999. Print.

Smook, G. A., and M. J. Kocurek. *Handbook for Pulp & Paper Technologists*. Atlanta, GA, U.S.A.: TAPPI, 1982. Print.

Appendix 1: Calculation of Annual Air Emission Limits

The annual limits of SO_2 and TPM emissions from the facility should be calculated as follows:

$$Annual\ limits = I \times P$$

where:

P is annual production calculated in accordance with Appendix 3, expressed in tonnes of production, and

I is the base level emission requirement, as follows:

a. In the case of a chemical facility:
   - 4.0 kg of SO_2/tonne of production
   - 2.0 kg of TPM/tonne of production
b. In the case of a mechanical facility:
   - 1.5 kg of SO_2/tonne of production
   - 0.5 kg of TPM/tonne of production

Appendix 2: Characterization of Sulphur Dioxide and Total Particulate Matter Air Emissions

1. General

Characterization of the emissions should include the following types of emission sources:

- Boiler
- Dissolving tank
- Thermal oxidizer
- Lime kiln
- Recovery boiler
- Other stationary combustion sources meeting the definition requirements

Characterization of the emissions should be expressed as follows:

- Sulphur dioxide should be expressed in tonnes of SO_2. *Measurement expressed in "S" should be converted to SO_2.*
- Total particulate matter (TPM) should be expressed in tonnes of TPM. Refer to the Definition section.

The characterization of SO_2 and TPM is based on a calendar year from January 1 to December 31.

2. Estimation methods

Emission sources subject to the Code of Practice can be characterized using the following measurement or estimation methods which are listed in hierarchical order:

I. Measurements using a continuous emission monitoring system (CEMS), only if it is calibrated and maintained in accordance with approved provincial or federal methods.

II. If no valid CEMS data is available, use measurements from a recognized sampling method listed in section 3.2.

III. If no emission measurements are available for the reporting year, use a site-specific emission factor for the emission source, calculated from the previous year's measurement results. The equipment must not have undergone major modifications that would affect the validity of the site-specific emission factor.

IV. If no site-specific emission factor is available, use industry-specific or generic emission factors such as AP-42[1] to estimate SO_2 or TPM emissions.

V. If no generic emission factor is available, use engineering calculations.

3. Guidance

This section provides guidance on how to calculate the annual SO_2 and TPM emission sources depending on the measurement or estimation method used:

3.1 Continuous measurements of TPM and SO_2

- Data from CEMS can be used only if calibration and maintenance are done regularly in accordance with approved provincial or federal method such as Environment Canada's Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from Thermal Power Generation (EPS 1/PG/7).
- The CEMS device should be maintained and operated in accordance with the manufacturer's specifications.
- The emission rates can be calculated by multiplying the concentration of the substance by the discharge flow rate or volumetric stack gas flow rate. Annual emissions of the substance can be estimated by adding emission data collected during the calendar year.

3.2 Stack testing

- The sampling for each source should be performed under the operating conditions specified by the provincial, municipal or federal authorities, or by the stack testing method used.
- The emissions data collected during stack sampling events should be used to determine annual total emissions through sound application of engineering calculations.

3.2.1 Stack testing recognized methods for TPM

- Environment Canada, *Reference Method for Source Testing: Measurement of Releases of Particulate from Stationary Sources*, EPS 1/RM/8 (Method E).
- U.S. EPA Method 5 - *Determination of particulate matter emissions from stationary sources.*
- U.S. EPA Method 5B - *Determination of nonsulfuric acid particulate matter emissions from stationary sources.*
- U.S. EPA Method 5D - *Determination of particulate matter emissions from positive pressure fabric filters.*

[1] AP-42, *Compilation of Air Pollutant Emission Factors*, U.S. Environmental Protection Agency, www.epa.gov/ttnchie1/ap42.

- U.S. EPA Method 17 - *Determination of particulate matter emissions from stationary sources.*

- U.S. EPA CTM 003 - *Determination of particulate matter (modified high volume sampling procedure).*

- Any other TPM stack testing method authorized by a provincial permit or regulation is allowed for assessing emissions.

3.2.2 Stack test recognized methods for SO_2

- Environment Canada, *Standard Reference Methods for Source Testing: Measurement of Emissions of Sulphur Dioxide from Stationary Sources*, EPS 1-AP-74-3.

- Environment Canada, *Reference Method for the Monitoring of Gaseous Emissions from Fossil Fuel-fired Boilers*, EPS 1/RM/15, September 1990.

- U.S. EPA Method 6 - *Determination of sulfur dioxide emissions from stationary sources.*

- U.S. EPA Method 6A - *Determination of sulfur dioxide, moisture, and carbon dioxide emissions from fossil fuel combustion sources.*

- U.S. EPA Method 6B - *Determination of sulfur dioxide and carbon dioxide daily average emissions from fossil fuel combustion sources.*

- U.S. EPA Method 6C - *Determination of sulfur dioxide emissions from stationary sources (Instrumental Analyzer Procedure).*

- U.S. EPA Method 8 - *Determination of sulfuric acid and sulfur dioxide emissions from stationary sources.*

- Any other SO_2 stack testing method authorized by a provincial permit or regulation is allowed for assessing emissions.

3.3 Emission factors

- A site-specific emission factor can be calculated and used for emission sources for which the previous year's measurement results are available (CEMS or sampling) and quantities of fuel or raw materials. Details of the emission factor calculation can be included in the emission assessment report.

- If a measurement device is used to measure the quantities of fuel or raw materials, the measurement devices should be installed, operated, maintained, and calibrated in accordance with the device manufacturer's instructions.

- If engineering calculations are used to estimate the quantities of fuel or raw materials, a brief description of the methodology used should be provided in the comment box of the emission assessment report.

- A generic emission factor such as AP-42[2] can be used for emission sources for which no measurements are available. The emission factor used to estimate SO_2 and TPM emissions should be noted in the emission assessment report.

[2] AP-42, *Compilation of Air Pollutant Emission Factors*, U.S. Environmental Protection Agency, www.epa.gov/ttnchie1/ap42.

Appendix 3: Determining Annual Production

The annual quantity of finished product should be aggregated by using the total daily production from January 1 to December 31.

The production of a finished product should be expressed in air-dried metric tonnes, as follows:

a) For pulp, if the water content is greater than 10%, the weight is to be adjusted such that this content does not exceed 10%; if the water content is equal to or less than 10%, the weight does not need to be adjusted;

b) For a paper product, the weight is that of the paper after it has been machine-dried.

The measurement of a finished product on an annual basis is in accordance with the *Pulp and Paper Effluent Regulations* (PPER) production measurement method.

Appendix 4: Emission Assessment Report Template

Name and civic address of the facility:

_____

_____

Period covered by report: From January 1 to December 31 (year) _____

Facility type chemical ☐ mechanical ☐

Total particulate matter (TPM)

Source	Annual quantity emitted (tonne)	Type of measurement (continuous, sampling or emission factor)	Method used or emission factor source
Recovery boilers			
Dissolving tanks			
Boilers			
Lime kilns			
Thermal oxidizers			
Other combustion sources (specify):			
Total quantity emitted (tonne)			
Calculated annual limit (tonne)			

Sulphur dioxide (SO_2)

Source	Annual quantity emitted (tonne)	Type of measurement (continuous, sampling or emission factor)	Method used or emission factor source
Recovery boilers			
Dissolving tanks			
Boilers			
Lime kilns			
Thermal oxidizers			
Other combustion sources (specify):			
Total quantity emitted (tonne)			
Calculated annual limit (tonne)			

Please send the completed report to:
Director
Environment and Climate Change Canada, Forest Products and *Fisheries Act* Division
Place Vincent Massey, 351 St. Joseph Blvd., Gatineau QC, K1A 0H3.
Email: ec.pflp-fpfa.ec@canada.ca

COMMENT BOX

If the total quantity emitted exceeds the total limit, provide possible causes where applicable and describe the actions planned to meet the limits or any other additional explanations as needed.

A separate document can be used for additional explanations

Confidentiality

An applicant who provides information to the Minister under section 313 of the Canadian Environmental Act may submit with the information a request that it be treated as confidential

An applicant who submits such a request that information contained in the application be treated as confidential must include with that request the identification of the following:

a) **any information that constitutes a trade secret;**
b) **any information the disclosure of which would likely cause material financial loss to, or prejudice the competitive position of, the applicant;**
c) **any information the disclosure of which would likely interfere with contractual or other negotiations being conducted by the applicant;**
d) **any financial, commercial, scientific or technical information that is confidential and is treated consistently in a confidential manner by the applicant; and**
e) **the reason why such information is confidential.**

I declare that this report is accurate and complete.

Operator's name (please print)	**Position title**
Telephone	**Email**
Operator's signature	**Date of signature**

Confidential Information

To promote transparency, information provided to the federal Department of the Environment may be treated as public information, unless a written request for confidentiality is submitted. The written

request for confidentiality should be submitted at the same time as the information is provided and must identify specific pieces of information that are considered to be confidential and the reasons why they should be treated as such.

Please send the completed report to:
Director
Environment and Climate Change Canada, Forest Products and *Fisheries Act* Division
Place Vincent Massey, 351 St. Joseph Blvd., Gatineau QC, K1A 0H3.
Email: ec.pflp-fpfa.ec@canada.ca